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DIAMOND DRILLING BLAST HOLES, BALMAT MINE ST. LAWRENCE COUNTY, N. Y.

BY

McHENRY MOSIER

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I. C. 7408,
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DIAMOND DRILLING BLAST HOLES, BALMAT MINE, ST. LAWRENCE COUNTY, N. Y.[1]

By McHenry Mosier[2]

SUMMARY

The application of diamond drills for blast holes is limited to the special job of extracting floor and stope pillars, and therefore their operation is intermittent. The zinc ore drilled occurs in metamorphosed dolomitic limestone. The mining method is sublevel open-stoping on 200-foot lifts. Ample fresh air is provided by mechanical ventilation.

Diamond drilling blast holes began in August 1944. Drills were mounted on a 3-inch quarry bar. The contract price for labor for operating equipment owned by the company was $0.23 per foot. The diamond bits were cast-set at the factory in a sintered tungsten matrix. Bit replacement costs were $0.15 to $0.20 per foot drilled. The feet drilled per bit ranged from 87 to 258. The feet drilled per diamond-drill shift ranged from 121 to 129. Holes were loaded with 60-percent special gelatin dynamite and fired electrically.

In percussion drilling, the estimated feet drilled per machine shift with hand-held sinkers was 65. The tons broken per machine shift averaged 40 throughout the mine. Detachable bits have been adopted recently.

The principal advantage of diamond-drilling blast holes at the Balmat mine is the extraction in a safe manner of ore not minable by short-hole drilling. The principal disadvantage is the greater cost per foot of hole in comparison with percussion drilling.

INTRODUCTION

This paper is one of a series undertaken by the Mining Branch of the Bureau of Mines to describe current practice in diamond drilling for production purposes at various mines throughout the United States and to discuss the relative merits of this method compared with drilling by percussion rock drills.

1/ The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Inf. Circ. 7408."

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The Bureau of Mines and the mining companies cooperating with it in this investigation have the common objective of developing information on this type of drilling and making it available to all who may be interested in improving mining operations.

The Balmat mine is owned and operated by the St. Joseph Lead Co. The operating data in this paper were furnished to the author by R. J. Mechin, general manager of the Balmat and Edward mines, and his staff in July 1946.

GEOLOGY

Metamorphic sedimentary rocks in the Grenville series of pre-Cambrian age are cut by pegmatite and granite dikes. The ore occurs as veins and irregular masses in the Grenville dolomitic limestone. The main ore body dips 42 degrees and rakes 30 degrees. The metallic minerals are sphalerite, galena, and pyrite in a gangue of silicates, calcite, and barite. The principal value of the ore is the zinc content.

MINING METHODS

The Balmat mine was developed for sublevel open-stoping by sinking an inclined shaft and driving main haulage levels from it on 200-foot vertical intervals starting at a depth of 300 feet. The grizzly sublevel is 30 feet above the haulage level. Grizzlies with either 85-pound rails or bulb angles on 10-inch spacing are installed at 50-foot intervals. Raises with an initial cross section of 4 by 4 feet are driven from the grizzly level to the haulage level above. From these raises, two mining sublevels on 57-foot intervals are extended to the limits of the ore.

The cross-sectional dimensions of the haulage drifts are 8 by 8 feet and of the mining sublevel drifts 4 by 7 feet.

Mining starts from the hanging wall at the first mining sublevel and proceeds in underhand fashion by 7-foot and 14-foot benches or steps downward to the grizzly level and laterally to the footwall by means of percussion drills.

Diamond drills are used for drilling blast holes in floor pillars and stope pillars. Thus, the application of diamond drills for blast holes is reserved for the special job of pillar extraction, which makes their operation intermittent.

Blasting is done with ammonia-gelatin dynamite having a strength of 60 percent. Delay electric blasting caps are used in stopes and development headings; prima-cord in fingers is used when blocked by coarse boulders; and ordinary safety fuse and blasting caps are used for blockholing boulders on grizzlies.

Mechanical ventilation by a 50,000-cubic-foot fan at the surface and booster fans at strategic locations underground provides ample fresh air throughout the mine.

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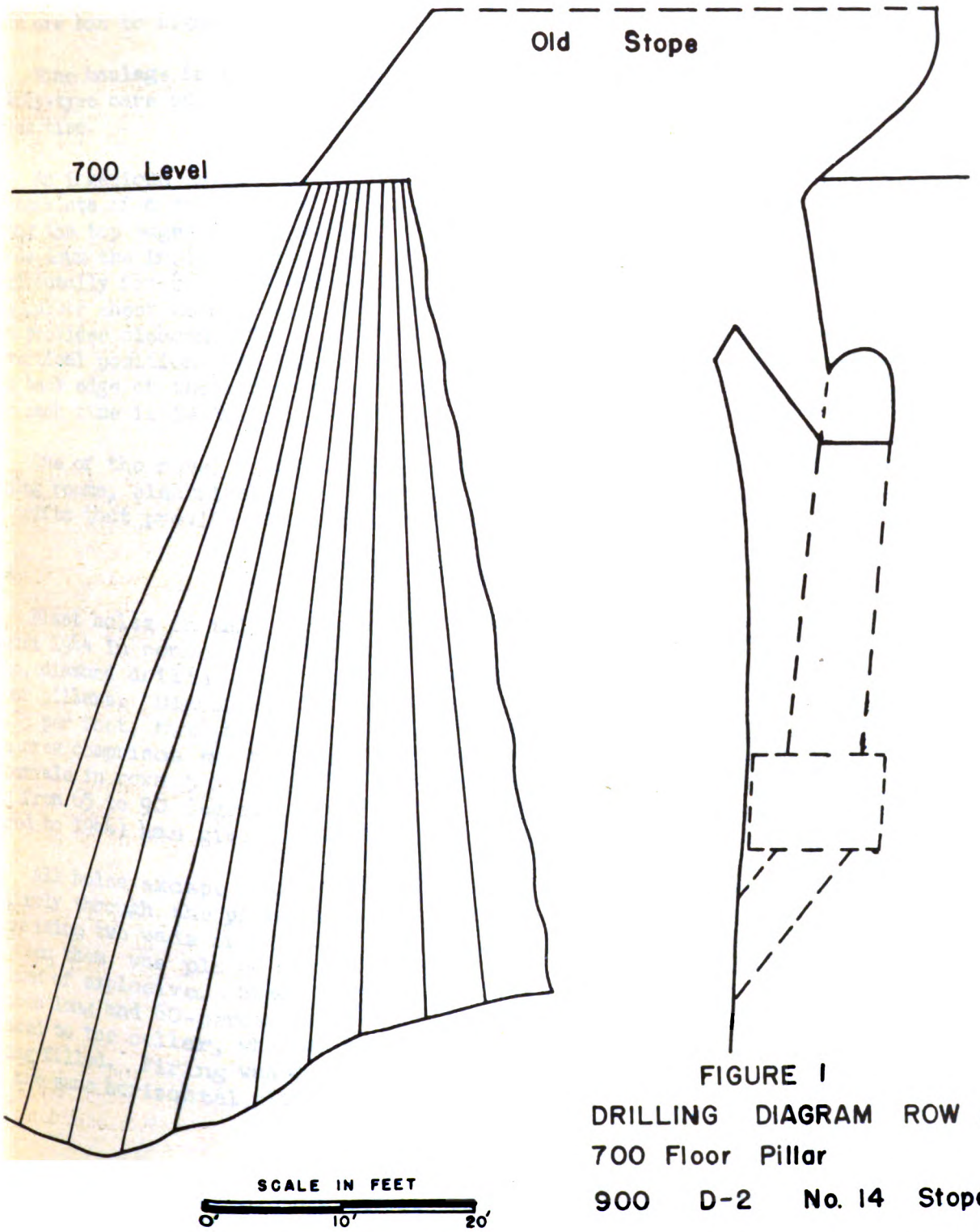

FIGURE 1
DRILLING DIAGRAM ROW A
700 Floor Pillar
900 D-2 No. 14 Stope

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Ore is hoisted in 7-ton skips loaded from 500-ton pockets constructed below haulage levels. A unique installation of an electric eye is at the main ore bin to signal the hoist-man when the bin is full.

Mine haulage is by 7.5-ton, storage-battery locomotives and 3-ton Granby-type cars on a 24-inch gage track laid with 30-pound rails on steel cross ties.

An ingenious device is effective in making the cars self-cleaning. It consists of a rubber sheet 3/8-inch thick, which is fastened by rivets along the top edge of the car body on the side opposite the door. It extends down the inside of the body to the floor of the car and continues horizontally for 8 inches across the bottom. The dumping operation causes the rubber sheet to move away from the side of the car as it is elevated and provides clearance for the 8-inch flap, so that it drops by gravity to a vertical position. By this motion the sheet carries the fine ore from the back edge of the car bottom, so that it falls freely from the tilted car each time it is dumped.

One of the novel features of equipment at the Balmat mine is the neat dining rooms, electrically heated, which are constructed in the stub ends of drifts that provide convenient facilities for small groups of men.

DIAMOND DRILLING

Blast holes in this mine were first drilled by diamond drills in August 1944 in connection with the removal of a floor pillar. Since that date, diamond drills have been used for the extraction of several other floor pillars. Diamond-drill operators are paid the contract price of $0.23 per foot; but the diamond-drill equipment is owned by the company. The crew comprises two men per drill. In 1946, holes were spaced on 4-foot intervals in rows 5 feet apart. They were all drilled down at angles ranging from 65 to 90 degrees. (See fig. 1.) The use of more dynamite (compared to 1944) has given better fragmentation of the broken ore.

All holes except some of those along the hanging wall were drilled entirely through the pillar to the open space below. One foot of stemming comprising two wads of a commercial cotton-stemming, with 6 inches of sand between them, was placed at the bottom of each hole and at the top of the column of explosive. Space blasting was effected by wooden spacers 12 inches long and 60-percent special gelatin dynamite. Every third hole was loaded to the collar, whereas the two intermediate holes lacked 30 feet of being filled. Firing was done electrically, and all exploders were placed in the same horizontal plane.

Equipment

One drill rig complete with all the accessories needed for blast-hole drilling was maintained at the Balmat mine. A duplicate drill was in service at the nearby Edwards mine, also owned by the St. Joseph Lead Co.

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These drills, which are gear-driven, have the following specifications:

Air motor:	
Type	Rotary
Horsepower at 80 pounds air pressure	10
Feed:	
Type	Screw
Run (length, inches)	27
Revolutions per inch of bit advance (range)	100-1200
Bit speed (range, rpm)	0-3300
Weight of drill, pounds	155
Capacity EX rods, feet	500

The diamond bits were cast set at the factory in a sintered tungsten matrix. Both concave pilot and concave plug types were used. All drill rods were greased with the manufacturer's rod dope to save wear and to decrease vibration.

Tamping sticks were made from wooden rods, 1-1/4 inches in diameter and 3 feet in length, by boring and filling them with lead and attaching sash cord.

Set-up

The standard practice was to mount the diamond drill on a 3-inch quarry bar 14 feet long. The bar was clamped on two 36-inch arms supported by two 7-foot columns, so that a row of holes could be drilled on two opposite sides of the columns. To reduce vibration, both ends of a chain looped over the quarry bar were fastened to the floor by steel wedges in 6-inch holes drilled in appropriate places for this purpose. The chain was tightened by two turnbuckles.

RESULTS OF DIAMOND DRILLING

The two principal items in the cost of diamond drilling are operating labor and diamond-bit replacement. At the Balmat mine in 1946 these two items totalled $0.38 to $0.43 per foot drilled. The drill crew comprised an operator and a helper, who could also run the drill. Operating data for work on the extraction of the floor pillar in 900, D-2, 14 stope, follow:

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Operating data, 900, D-2, 14 stope

	February, March, April 1946	May, June 1946
Number of holes drilled	77	46
Feet drilled:		
Total	4,825	1,928
EX concave plug bit		606
EX concave pilot bit	1,546	1,322
Special concave plug bit to drill hole 1-1/8 inch diameter	3,279	
Feet drilled per bit:		
Total all bits	193	129
EX concave plug bit		87
EX concave pilot bit	258	165
Special concave plug bit	173	
Diamond-drill shifts	40	15
Feet drilled per diamond-drill shift	121	129
Depth of hole:		
Average	63	42
Maximum	86	100
Labor, contract per foot	$0.23	$0.23
Diamond-bit replacement per foot	$0.15	$0.20
Short tons broken (estimated):		
Total	4,825	2,892
Per foot of hole drilled	1	1.5
Primary blasting:		
60 percent gelatin dynamite, pounds.	2,250	1,200
Pounds dynamite per ton broken	0.47	0.42
Secondary blasting:		
(Not completed)		

PERCUSSION DRILLING

Three types of wet drills were in operation with one man per drill. Mounted drills (drifters) were employed in development drifts, stopers in raises, and hand-held sinkers for benching in stopes. One-inch hexagonal drill steel with 1.75-inch starter bits were standard except for block-holing, where 7/8-inch steel was used. Holes in stope drilling with sinkers had a maximum length of 14 feet and an average of 8 feet.

The tons broken per machine shift averaged 40 throughout the mine. The estimated feet drilled per machine shift with hand-held sinkers was 65 and with mounted drills 120.

The cost of sharpening conventional drill steel for sinker drills plus drill-steel replacement was 2.5 cents per foot drilled. Recently, detachable bits have been adopted.

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The detachable bits are hot-milled at the rate of 200 per hour. To heat the bits for hardening, an oil furnace with automatic temperature control is used. The bits are quenched in water maintained at a temperature of 80 to 100 degrees. The water rises from sprays to a depth of 7/16 inch in the container.

RELATIVE MERITS OF DIAMOND-DRILLING BLAST HOLES AT THE BALMAT MINE

The advantages of diamond-drilling blast holes are:

1. Ore not minable by short-hole drilling can be recovered.

2. There is greater safety to the miner when drilling floor pillars.

3. The work is easier for the miner on pillar extraction.

4. Men can be trained more easily to operate diamond drills on blast holes than percussion drills.

5. As both men in each diamond-drill crew have been trained to operate the drill, it is a simple matter, should one man fail to report for duty, to recruit a helper from other workers in the mine to substitute for him during his absence.

On the other hand, the disadvantages of diamond-drilling blast holes are:

1. The drill holes are harder to keep in alinement, owing to their greater length.

2. More skill and closer supervision are required to load and fire a large number of long holes in one blast.

3. The cost is greater per foot of hole drilled.

CONCLUSIONS

Ore in floor pillars and stope pillars that could not be recovered without undue hazard to workmen when drilling short holes with percussion drills can be mined safely by diamond-drilling long holes.

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